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In re the Application of:

Koji Shigemura

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Confirmation No. 9396

Filed: November 21, 2003 Examiner: James Lin

For: DEPOSITION MASK FRAME ASSEMBLY, METHOD OF FABRICATING THE SAME, AND METHOD OF FABRICATING ORGANIC ELECTROLUMINESCENT DEVICE USING THE DEPOSITION MASK FRAME ASSEMBLY

SUBMISSION OF ENGLISH TRANSLATION OF PRIORITY DOCUMENT

Mail Stop Appeal Brief—Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Pursuant to 37 CFR 1.55(a)(4) and MPEP 201.15, attached hereto are an English translation of Japanese Patent Application No. 2002-339616 filed on November 22, 2002, the Japanese priority application of the present application, and a Certification of Translation containing a statement that the English translation is accurate to perfect the applicant's claim for foreign priority under 35 USC 119(a)-(d). A certified copy of the Japanese priority application was filed on November 21, 2003.

If there are any fees associated with filing of this paper, please charge the same to our Deposit Account No. 503333.

Respectfully submitted,

STEIN, MCEWEN & BUI, LLP

Date: 02/14/08

By: Randall Svihla

Randall S. Svihla
Registration No. 56,273

1400 Eye St., N.W.
Suite 300
Washington, D.C. 20005
Telephone: (202) 216-9505
Facsimile: (202) 216-9510

Attachments

CERTIFICATION OF TRANSLATION

I, ***Seung-hye Kim***, an employee of Y.P.LEE, MOCK & PARTNERS of The Koryo Bldg., 1575-1 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare under penalty of perjury that I understand the Japanese language and the English language; that I am fully capable of translating from Japanese to English and vice versa; and that, to the best of my knowledge and belief, the statements in the English language in the attached translation of ***Japanese Patent Application No. 2002-339616.*** consisting of 21 pages, have the same meanings as the statements in the Japanese language in the original document, a copy of which I have examined.

Signed this 14th day of February 2008

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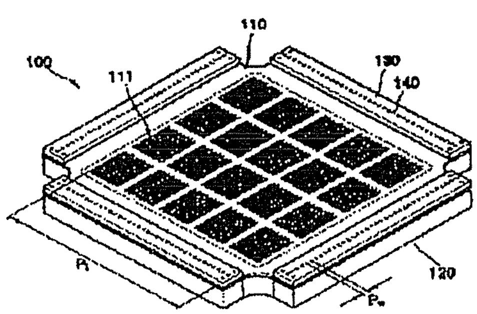
DEPOSITION MASK FRAME ASSEMBLY, METHOD OF MANUFACTURING THE SAME, AND METHOD OF MANUFACTURING ORGANIC ELECTROLUMINESCENT DEVICE USING THE DEPOSITION MASK FRAME ASSEMBLY

[Abstract]

PROBLEM TO BE SOLVED: Provided are a deposition mask frame assembly, a method of manufacturing the same, and a method of manufacturing an organic electroluminescent (EL) device using the deposition mask frame assembly by which generation of cracks due to welding of a mask and a frame is reduced.

SOLUTION: The deposition mask frame assembly includes a mask which is a thin plate in which a predetermined pattern of apertures is formed; a frame supporting one surface of the mask so that the mask is tensed; and a cover mask supporting the other surface of the mask which corresponds to the frame.

SELECTED DRAWING: FIG. 3



[Claims]

1. A deposition mask frame assembly comprising:

a mask which is a thin plate in which a predetermined pattern of apertures is formed;

a frame supporting one surface of the mask so that the mask is tensed; and

a cover mask supporting the other surface of the mask which corresponds to the frame.

2. The deposition mask frame assembly of claim 1, wherein the mask is formed of either nickel or an alloy of nickel or cobalt.

3. The deposition mask frame assembly of claim 2, wherein the mask is formed by electro-forming.

4. The deposition mask frame assembly of any one of claims 1 through 3, wherein the mask, the frame, and the cover mask are joined together by welding.

5. The deposition mask frame assembly of claim 4, wherein the welding is a dot welding method, and a welding pitch, which is an interval between welding dots, is 3mm or less.

6. A method of manufacturing a deposition mask frame assembly, the method comprising:

electrodepositing a metal to a predetermined thickness using an electrodepositing plate having a pattern corresponding to a mask pattern by electro-forming;

separating a mask from the electrodepositing plate; and

installing a frame on one surface of the mask and installing a cover mask on the other surface of the mask while the mask is being tensed, and welding the cover mask, the mask, and the frame.

7. The method of claim 6, wherein the mask is electrodeposited of either nickel or an alloy of nickel and cobalt.

8. A method of manufacturing an organic EL device in which an organic light-emitting film is deposited using the deposition mask frame assembly of any one of Claims 1 through 5.

[Detailed Description of the Invention]

[Technical Field of the Invention]

[0001] The present invention relates to a deposition mask frame assembly, a method of manufacturing the same, and a method of manufacturing an organic electroluminescent (EL) device using the deposition mask frame assembly, and more particularly, to a mask frame assembly for depositing a thin film that constitutes an organic EL device.

[Background Art]

[0002] EL devices, which are spontaneous light-emitting display devices, provide a wide viewing angle, a good contrast, and a high response speed. Accordingly, much attention is paid on EL devices because they can be used as a next-generation display device.

[0003] Such organic EL devices include first electrodes formed in a predetermined pattern on a transparent insulating substrate, an organic film formed on the first electrodes by vacuum deposition, and second electrodes formed as a cathode electrode layer on the organic film such that the first and second electrodes cross each other.

[0004] In the manufacture of the organic EL devices having such a structure, the first electrodes are typically formed by patterning indium tin oxide (ITO) using a photolithographic method by a wet etching method from among a plurality of etching methods using ferric chloride ($FeCl3 \cdot 6H2O$).

[0005] Such a photolithographic method can be used before an organic film is formed, but causes a problem when it is used after an organic film is formed. Because the organic film is very weak for water, it must be thoroughly isolated from water while being manufactured and even after the manufacturing. However, the photolithographic

method including an exposure to water during pealing-off and etching of resist, so it is not suitable for the organic film and the cathode electrode layer.

[0006] This problem is usually solved by vacuum-depositing an organic light emissive material for the organic film and a material for the cathode electrode layer using a patterned mask. In particular, it is known that a vacuum deposition is the most appropriate to pattern an organic film formed of a low molecular organic material.

[0007] A technique of patterning an organic film, which is a light-emitting layer, using a mask is very important in the manufacture of full-color organic EL devices.

[0008] Examples of conventional full-color organic EL device coloring methods include a three-color independent deposition method of independently depositing three red (R), green (G), and blue (B) color pixels on a substrate, a color conversion method (CCM) of forming a color conversion layer on a light emissive surface using a blue light source, and a color filtering method which uses a white light source and a color filter. The three-color independent deposition method attracts much attention because it is simply performed and provides a high color purity and efficiency.

[0009] In the three-color independent deposition method, a high accurate mask must be used to independently deposit three R, G, and B color pixels on a substrate. In particular, a high accuracy of the positions of deposited pixels, that is, a high accuracy of the widths of pattern apertures, is required, and a high accuracy of a total mask pitch is also required.

[0010] A mask 10 used to deposit an organic film or electrodes upon the manufacturing of an organic EL device is typically supported by a frame 20 so that the mask 10 is tensed as shown in FIG. 1. The mask 10 is comprised of a single metal thin plate 11 and masking pattern units 12, which allow a plurality of substrate units that constitute an organic EL device to be deposited on the metal thin plate 11.

[0011] Because the mask 10 is thinly formed and minutely patterned, if it is used without any treatment, some parts of it may droop, preventing an accurate patterning. Accordingly, as shown in FIG. 1, an optimal tension is applied to the mask 10 to obtain a predetermined accuracy of a total pitch (Pt), and the tensed mask 10 is coupled to the

mask frame 20. Upon the coupling, it is important to not change the Pt accuracy. The coupling of the mask 10 to the mask frame 20 can be achieved by various methods, for example, using an adhesive, by laser welding, or by resistance welding.

[0012] The mask 10 may be manufactured by etching or electro-forming.

[0013] In the manufacture of the mask 10 by etching, a photoresist layer having a pattern of slits 11 is formed on a thin plate, or a film having a pattern of slits 11 is attached to a thin plate, and then the resulting plate is etched.

[0014] However, although the etching method has an advantage in that a width of apertures in the pattern of the slits 11 are not controlled by the thickness of the thin plate, the etching method has a low measuring accuracy of the pattern and thus designing of the pattern to be fine may be restrictive.

[0015] On the other hand, the electro-forming method has a principle that a metal is deposited on a prototype to a desired thickness by the electrolysis of a metallic salt solution through an operation such as electrical plating, and then peeled off from the prototype to obtain a metal product having an uneven surface whose prominences and depressions are arranged opposite to those of the prototype. According to this principle, a mask is manufactured.

[0016] In the method of manufacturing a mask by the electro-forming method, an alloy of nickel (Ni) and cobalt (Co) is used as the material of the mask. The use of the Ni-Co alloy increases the roughness of a manufactured surface and the accuracy of a slit pattern. On the other hand, because the Ni-Co alloy has a poor weldability, a crack is generated in a mask when the Ni-Co alloy is welded into a frame. In other words, when cobalt is alloyed with another metal, its hardness and intensity increase, and accordingly fragility increases, which helps a crack to be easily generated upon welding.

[0017] This crack generation can be seen from FIGS. 2A through 2C. Referring to FIG. 2A, when the mask 10 and the frame 20 are welded by a laser welder 21, a gap 14 is generated around a joint 13 by heat flexion. If the welding continues on the resultant structure having the gap 14 as shown in FIG. 2B, a crack 15 is generated as shown in FIG. 2C. Due to this crack generation, the tension which supports a mask partially

decreases, and accordingly the accuracy of the total pitch of the mask varies. Thus, accurate patterning is impossible.

[0018] Accordingly, although the mask 10 and the frame 20 can be coupled by using the adhesive, the adhesive may not be easily controlled when the tension is applied to the mask 10. For example, because temperature is increased when the adhesive is hardened, due to a thermal expansion of the adhesive between the mask 10 and the frame 20, the accuracy of the total pitch is decreased. A change of the accuracy of the total pitch of the mask 10 which is generated by the thermal expansion of the adhesive is larger than the change of the accuracy of the total pitch of the mask 10 which is generated when the mask 10 and the frame 20 are welded by a laser welder 21.

[0019] A deposition screen mask in which highly accurate patterning is possible is disclosed in Reference Patent 1.

[0020] The disclosed mask includes a mask portion and a screen portion. The mask portion is a deposition mask used to form a patterning film on a substrate by deposition, and has partitions for defining a plurality of first apertures. The screen portion has a plurality of second apertures smaller than the first apertures, and a magnetic material in which the second apertures are disposed on the first apertures of the mask portion. Here, an alloy of nickel is used as the first apertures.

[0021] Reference Patent 2 discloses the structure of a magnetic mask. Reference Patent 3 discloses a deposition mask frame assembly, in which a patterned mask masks a deposition area in a close adherence to a material to be deposited and has finer gaps and finer patterns incapable of supporting a predetermined size than the thickness of a frame. The fine patterns of the patterned mask are supported by fine ribs.

[0022] These disclosed masks are closely adhered to a material to be deposited because they are formed of a magnetic material. However, due to the limits of the mask materials, these masks still have fundamental problems, such as, a poor welding, and a variation in the accuracy of a total pitch due to the poor welding.

[0023] Reference Patent 4 discloses a pattern forming apparatus for preventing a film pre-formed on a substrate from being damaged due to partial coming-off of a mask from a frame due to a thermal expansion during deposition. The pattern forming apparatus includes a support which is formed to be larger than the mask and has a dent portion to seat the mask onto the dent portion. The user of the support prevents a mask from being bent in waves due to a thermal expansion during the formation of a film. Also, by forming a magnetic element on the side of the mask other than the side on which the support is formed, the magnetic element makes the mask closer to the substrate so that a space between the mask and the support is created. Thus, the space contributes to cooling the mask.

[0024] However, because the disclosed mask having slits is not firmly supported by the frame, the location of the mask cannot be accurately controlled, and the location of the mask may be changed during deposition.

[0025] Reference Patent 5 discloses a pattern forming apparatus for preventing a mask from being expanded by heat during the formation of a film, in which a liquid path is formed within a frame which supports the mask, and a cooling solution circulates within the liquid path. However, this disclosure also has a problem such as a change in the accuracy of a total pitch due to a poor welding of a mask and a frame.

[0026] Reference Patents 6, 7, 8 and 9 disclose a metal mask including supplementary lines to prevent drooping of a mask shield between the mask and a frame. These masks also have fundamental problems such as a poor welding due to the limits of the material of a mask.

[Reference Patent 1]

Japanese Patent Publication No. 2001-247961

[Reference Patent 2]

Japanese Patent Publication No. 2001-273976

[Reference Patent 3]

Japanese Patent Publication No. 2001-254169

[Reference Patent 4]

Japanese Patent Publication No. 2002-9098
[Reference Patent 5]
Japanese Patent Publication No. 2002-8859
[Reference Patent 6]
Japanese Patent Publication No. 2000-48954
[Reference Patent 7]
Japanese Patent Publication No. 2000-173769
[Reference Patent 8]
Japanese Patent Publication No. 2001-203079
[Reference Patent 9]
Japanese Patent Publication No. 2001-110567

[Technical Goal of the Invention]

[0027] The present invention provides a deposition mask frame assembly, a method of manufacturing the same, and a method of manufacturing an organic electroluminescent (EL) device using the deposition mask frame assembly by which generation of cracks due to welding of a mask and a frame is reduced.

[Means for Achieving Technical Goal]

[0028] According to an aspect of the present invention, there is provided a deposition mask frame assembly including a mask which is a thin plate and has a predetermined pattern of apertures, a frame which supports one surface of the mask so that the mask is tensed, and a cover mask which supports the other surface of the mask which corresponds to the frame.

[0029] The mask is formed of either nickel or an alloy of nickel or cobalt by electro-forming.

[0030] The mask, the frame, and the cover mask are joined together by dot welding. The dot welding is performed so that a welding pitch, which is an interval between welding dots, is 3mm or less.

[0031] According to another aspect of the present invention, there is provided a method of manufacturing a deposition mask frame assembly. In this method, a metal is electrodeposited to a predetermined thickness using an electrodepositing plate having a pattern corresponding to a mask pattern by electro-forming. Next, a mask is separated from the electrodepositing plate. Thereafter, a frame is installed on one surface of the mask and installing a cover mask on the other surface of the mask while the mask is being tensed, and welding the cover mask, the mask, and the frame.

[0032] Here, the mask is electrodeposited of either nickel or an alloy of nickel and cobalt.

[0033] According to still another aspect of the present invention, there is provided a method of manufacturing an organic EL device in which an organic light-emitting film is deposited using the above-described deposition mask frame assembly.

[Mode of the Invention]

[0034] Hereinafter, the present invention will be described in detail by explaining embodiments of the invention with reference to the attached drawings.

[0035] FIG. 3 illustrates a deposition mask frame assembly 100 according to a preferred embodiment of the present invention.

[0036] Referring to FIG. 3, the deposition mask frame assembly 100 includes a mask 110 having a plurality of mask units 111 and a frame 120 which supports the mask 110 so as to apply a tension to the mask 110. The frame 120 is hollow so as to support the edge of the mask 110 excluding the mask units 111.

[0037] As shown in FIG. 4, the mask units 111 include a pattern of apertures 112 which are defined by shielding portions 113 on strips. As shown in FIG. 4, the apertures 112 are formed in an elongated pattern, but they may be patterned differently.

[0038] As shown in FIG. 3, the edge of one surface of the mask 110 is supported by the frame 120, while the edge of the other surface of the mask 110 is supported by a cover mask 130. The cover mask 130 is configured such as to support the four edges

of the mask 120, but any structure is available if it can support the portion of the mask 110 supported by the frame 120.

[0039] The mask 110 can be made of either nickel or an alloy of nickel and cobalt. Preferably, the mask 110 can be made of the nickel-cobalt alloy, which facilitates the formation of fine patterns and provides an excellent surface roughness. The apertures 112 of the mask 110 are formed in a predetermined pattern by an electro-forming method so as to obtain a fine pattern and an excellent surface smoothness.

[0040] The cover mask 130 can be formed of Invar, which is mainly composed of Fe and Ni, or 42 alloy, or stainless steel SUS304. Here, SUS denotes steel special use stainless of Japanese Industrial Standards. The frame 120 can be formed of stainless steel SUS410. Definitely, the cover mask 130 or the frame 120 may be formed of various materials.

[0041] As shown in FIG. 3, the mask 110, the cover mask 130, and the frame 120 are joined together in such a way that the mask 110 is located between the cover mask 130 and the frame 120. The joining may be achieved using an adhesive agent, preferably by welding. Here, there are various welding methods such as laser welding or resistance welding. When considering an accuracy change after the joining, laser welding is preferable. Welding dots 140 of FIG. 3 denote dots used upon dot welding using laser. A welding pitch Pw is controlled depending on a change in the accuracy of a total pitch after the joining. Preferably, the welding pitch Pw is controlled to 3mm or less, which will be described later in detail.

[0042] As described above, the deposition mask assembly 100 uses the mask 110 manufactured by electro-forming using nickel or a Ni-Co alloy, thus providing an accurate pattern and an excellent surface smoothness. In addition, the deposition mask assembly 100 prevents a crack due to heat refraction at the welding dots by employing the cover mask 130 attached to one side of the mask 110, thus preventing the total pitch from varying due to a poor welding, which is a weak point of the Ni-Co alloy.

[0043] FIG. 5 is a cross-sectional view taken along line A-A of FIG. 4. In practice, a surface 113a of the individual shielding portions 113, which contacts a substrate on which deposition is made, can have a surface smoothness of 0.1 μm. Each of the apertures 112 can have a width tolerance ΔWs1 of ±5 μm. The accuracy of the total pitch Pt can be ±10 μm.

[0044] A method of manufacturing a deposition mask frame assembly according to the present invention will now be described with reference to FIGS. 6A through 6C.

[0045] First, the mask 110 is manufactured by electro-forming. Although not shown in the drawings, a metal layer is electrodeposited on an exposed portion of an electrodepositing plate using an electro-forming method. Here, the electrodepositing plate has a film attached on its area corresponding to shielding portions that form the outer portion of the mask 110 and define the apertures 112. Preferably, the metal layer is formed of nickel or an alloy of nickel and cobalt. Although the metal layer can be electrodeposited to a thickness of about 30 to 50 μm, the thickness may definitely vary according to the conditions of the user of the mask 110.

[0046] After the completion of the electrodeposition for manufacturing the mask 110, the mask 110 is separated from the electrodepositing plate. As shown in FIG. 6A, the mask 110 interposes between the frame 120 and the cover mask 130. Preferably, the inner circumference of the cover mask 130 is made larger than the outer circumference of a substrate (not shown) on which a film is to be deposited, in order to prevent a shadow effect which occurs during deposition when the cover mask 130 contacts the substrate due to a smaller inner circumference of the cover mask 130 than the outer circumference of the substrate.

[0047] As shown in FIG. 6B, the mask 110 is clamped and subjected to a tension in directions x and y. Here, the same tension can be applied in directions x and y. However, it is preferable that the four sides are subjected to optimal tensions +Px1 to +Px5, -Px1 to –Px5, +Py1 to +Py6, and -Py1 to –Py6, respectively. In this case, as shown in FIG. 7A, there is no deviation because the total pitches Pt between two outmost lines 114 and 115 are uniform. As shown in FIGS. 7B and 7C, the total pitch

Pt may have a deviation (Ptma - Ptmin). As shown in FIGS. 7B through 7D, a line deviation (ΔX) may occur. Consequently, the application of different tensions for different sides of the mask can reduce the deviation of the total pitch and the line deviation.

[0048] As can be seen from FIG. 6C, while the mask 110 is being tensed, the mask 110, the cover mask 130, and the frame 120 are joined together. As described above, the joining can be accomplished by any method, such as, an adhesion or welding. However, laser dot welding is preferable, when considering an accuracy change or the like caused after the joining. Here, the welding pitch Pw between welding dots 140 must consider a change in the accuracy of the total pitch obtained after tension is removed after the joining. The relationship between a change in the total pitch and a change in the welding pitch when the tension has been removed after welding is shown in FIG. 8. As can be seen from FIG. 8, a variation in the total pitch decreases as the welding pitch decreases, and the variation in the total pitch is very small at the welding pitches of 3mm or less. Thus, it is preferable that the welding pitch Pw is 3mm or less. Under this condition, even when a mask is made of a Ni-Co alloy, welding dots are supported by a cover mask and a frame respectively installed on the upper and lower surfaces of the mask, such that a transformation of the mask due to heat refraction is prevented. Consequently, generation of cracks is prevented.

[0049] After the above-described welding is completed, a portion 142 of the cover mask 130 and the edge of the mask 110 are cut off so that the sizes and shapes of the cover mask 130 and the mask 110 match with those of the frame 120.

[0050] The characteristics of an organic EL device manufactured using a deposition mask frame assembly according to the present invention relative to an organic EL device using a conventional deposition mask frame assembly are shown in Table 1.

[0051] In Table 1, first through third embodiments show organic EL devices manufactured using a deposition mask frame assembly according to the present invention, in which a cover mask is added to a mask formed of a Ni-Co alloy by electro-forming. A first comparative example shows an organic EL device using a

mask formed of a Ni-Co alloy by a conventional electro-forming method. Second through fourth comparative examples show organic EL devices using a mask manufactured by etching.

[0052] [Table 1]

	Embodiment 1	Embodiment 2	Embodiment 3	Comparative example 1	Comparative example 2	Comparative example 3	Comparative example 4
ΔPt	±5μm	±5μm	±5μm	±10μm	±5μm	±5μm	±5μm
ΔX	±3μm	±3μm	±3μm	±5μm	±3μm	±3μm	±3μm
ΔWs1	±5μm	±5μm	±5μm	±5μm	±10μm	±10μm	±10μm
Pixel pitch	130ppi	150ppi	100ppi	130ppi	130ppi	100ppi	100ppi
Aperture efficiency	60%	55%	69%	60%	60%	69%	58%
Luminance failure rate	0%	0%	0%	9%	14%	12%	0%
Color mixture generation rate	0%	0%	0%	3%	5%	3%	0%
Blind generation rate	0%	0%	0%	0%	1.2%	1.2%	1.2%
Pixel short generation rate	0%	0%	0%	0%	0.5%	0.5%	0.5%

[0053] In Table 1, ΔPt denotes a deviation of a total pitch obtained after a tension has been removed after welding, ΔX denotes a line deviation, and ΔWs1 denotes a deviation of an aperture width. The luminance failure rate is caused when an organic emission film is incompletely deposited on a pixel area of the organic EL device. The color mixture generation rate denotes a case in which two organic emission films are overlapped on a single pixel, that is, a case in which color mixture occurs. Accordingly, the luminance failure rate and the color mixture generation rate represent that apertures formed in a mask have not been accurately patterned. The blind generation rate denotes a value obtained by dividing a blind that occurs at the same area on different substrates by the number of assessed pixels. The pixel short generation rate denotes

a value obtained by dividing a pixel short that occurs at the same area on different substrates by the number of assessed pixels.

[0054] As can be seen from Table 1, the first through third embodiments according to the present invention provide a significantly lower luminance failure rate and a significantly lower color mixture generation rate than those of the second through fourth comparative examples in which a deposition mask frame assembly manufactured by an existing etching method is used. Also, it can be seen from Table 1 that the present invention prevents generation of a blind or a pixel short.

[0055] Furthermore, the first through third embodiments of the present invention provide a lower luminance failure rate and a lower color mixture generation rate than those of the first comparative example in which a deposition mask frame assembly manufactured by an existing electro-forming method is used, because in the first comparative example, a patterning failure occurs due to a degradation of the weldability of a Ni-Co alloy used to manufacture a mask of the deposition mask frame assembly in the first comparative example.

[0056] FIG. 9 is a graph of an aperture efficiency versus a pixel pitch in cases I and II where a deviation ($\Delta Ws1$) of the widths of apertures of a mask is ±5μm and ±10μm, respectively. The first through third embodiments of the present invention and the first comparative example in Table 1 correspond to the case I, and the second through fourth comparative examples in Table 1 correspond to the case II. Here, a cathode space is 25μm. As shown in FIG. 9, the present invention provides an aperture efficiency of 50% or greater even when pixels are miniatured to a pixel pitch of 170ppi. Thus, the use of a deposition mask frame assembly according to the present invention enables to obtain a full-color organic EL device of quality.

[0057] Also, in case a deposition mask is manufactured by electro-forming, shielding portions which define apertures have a rectangular shape, thus reducing a shadow effect which occurs during deposition.

[0058] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary

skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

[Effect of the Invention]

[0059] A deposition mask frame assembly according to the present invention, a method of manufacturing the same, and a method of manufacturing an organic EL device using the same provide the following effects.

[0060] Firstly, generation of cracks due to welding of a mask and a frame is minimized, and transformation of the mask is also minimized.

[0061] Secondly, a welding failure can be minimized even when the mask is formed of a Ni-Co alloy, and the accuracy of the widths of apertures, the accuracy of a total pitch, and a surface smoothness can be increased simultaneously.

[0062] Thirdly, the deposition failure rate of pixels is lowered, such that generation of a luminance failure and a color mixture can be reduced.

[0063] Fourthly, pixels can be highly miniaturized with a high aperture efficiency, and an organic film or other electrodes can be deposited with a low loss. Thus, generation of a blind and a pixel short can be reduced.

[Brief Description of the Drawings]

FIG. 1 is an exploded perspective view of a conventional deposition mask frame assembly;

FIG. 2A is a cross-sectional view for illustrating a process in which a crack is generated around a joint where a mask made of an alloy of nickel and cobalt joins to a frame;

FIG. 2B is a cross-sectional view for illustrating a process in which a crack is generated around a joint where a mask made of an alloy of nickel and cobalt joins to a frame;

FIG. 2C is a cross-sectional view for illustrating a process in which a crack is generated around a joint where a mask made of an alloy of nickel and cobalt joins to a frame;

FIG. 3 is a perspective view of a deposition mask frame assembly according to a preferred embodiment of the present invention;

FIG. 4 is a partial perspective view of the mask of FIG. 3;

FIG. 5 is a cross-sectional view taken along line A-A of FIG. 4;

FIG. 6A is a perspective view for illustrating a process for manufacturing a deposition mask frame assembly according to the present invention;

FIG. 6B is a perspective view for illustrating a process for manufacturing a deposition mask frame assembly according to the present invention;

FIG. 6C is a perspective view for illustrating a process for manufacturing a deposition mask frame assembly according to the present invention;

FIG. 7A shows a deviation of the total pitch of a deposition mask frame assembly and a line deviation of the deposition mask frame assembly;

FIG. 7B shows a deviation of the total pitch of a deposition mask frame assembly and a line deviation of the deposition mask frame assembly;

FIG. 7C shows a deviation of the total pitch of a deposition mask frame assembly and a line deviation of the deposition mask frame assembly;

FIG. 7D shows a deviation of the total pitch of a deposition mask frame assembly and a line deviation of the deposition mask frame assembly;

FIG. 8 is a graph of a total pitch after a tension is removed after welding versus a welding pitch; and

FIG. 9 is a graph of an aperture efficiency based on a deviation of the widths of apertures of a mask versus a pixel pitch.

[Explanation of Reference numerals]

100 ------ deposition mask frame assembly

110 ------ mask units

111 ------ mask units

112 ------ apertures

113 ------ shielding portions

120 ------ frame

130 ------ cover mask

140 ------ welding dots

FIG. 1

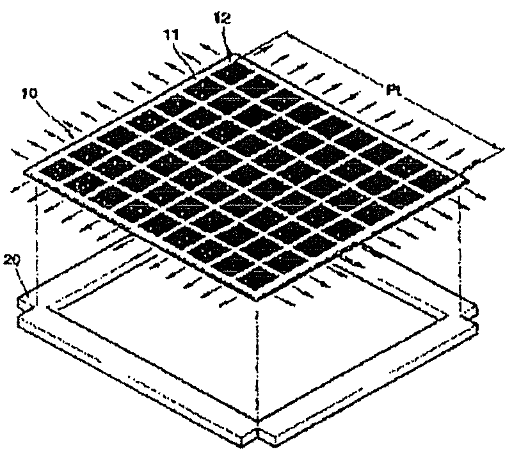


FIG. 2A

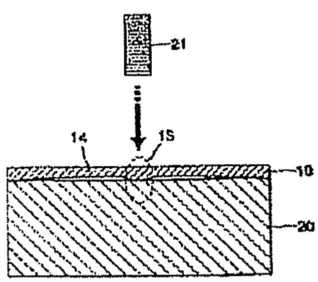


FIG. 2B

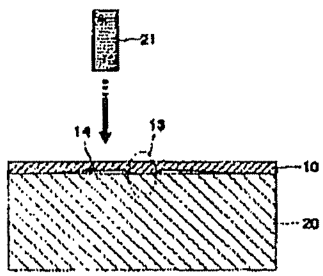


FIG. 2C

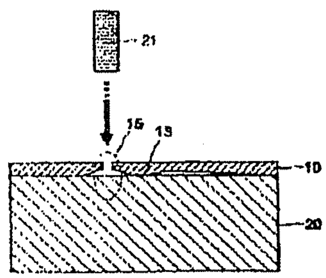


FIG. 3

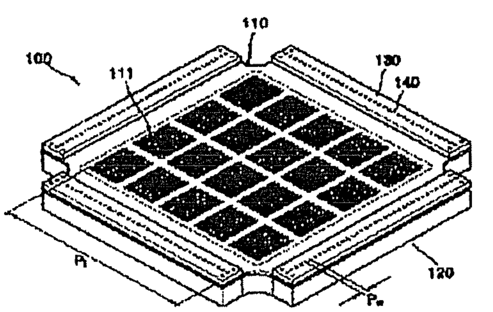


FIG. 4

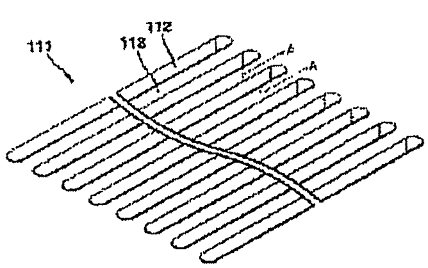


FIG. 5

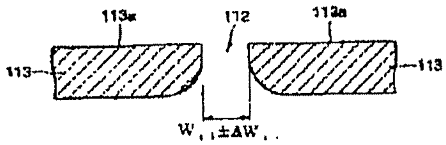


FIG. 6A

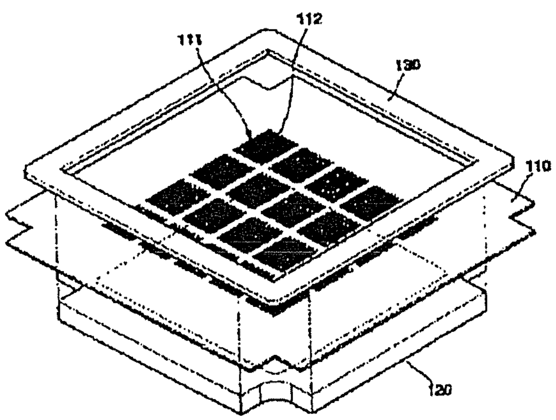


FIG. 6B

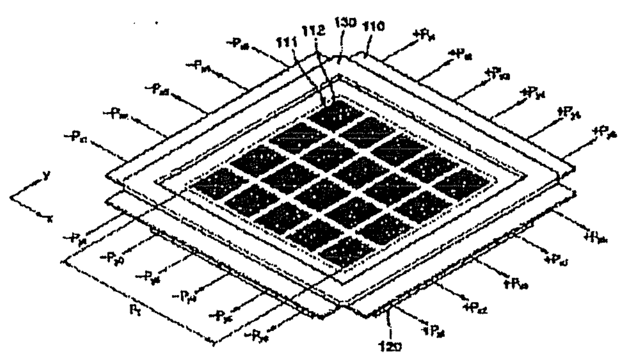


FIG. 6C

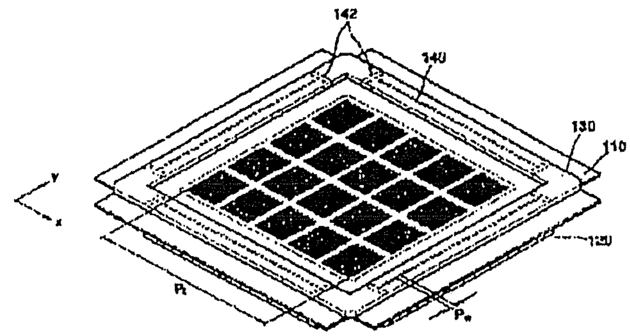


FIG. 7A

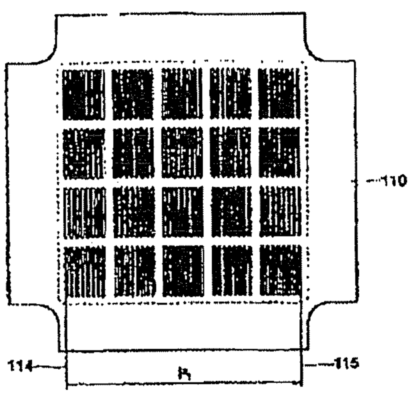


FIG. 7B

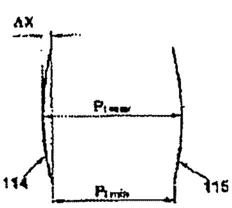


FIG. 7C

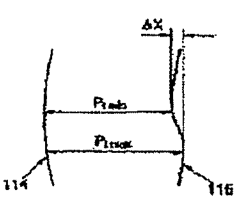


FIG. 7D

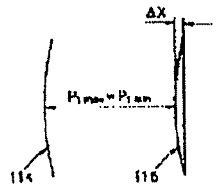


FIG. 8

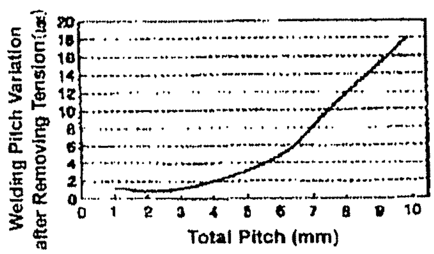


FIG. 9